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APPLICATIONS OF GPS IN AIRBORNE ELECTRONIC
COUNTERMEASURE RECONNAISSANCE

by

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I. INTRODUCTION

When implementing electronic counter reconnaissance or other electronic countermeasure missions on moving platforms, operating personnel working on the platforms must grasp in real time the exact position of the platform itself. In command posts or control centers, there is a need to understand, in real time, the direction of platform movements. When implementing the positioning of emiting sources, precise platform locations are even more indispensible. In the past, on aircraft, reliance was put on inertial navigation systems and aviation instruments to provide data and, after processing, precise positions. The limitations associated with making use of this type of method are relatively large. Precisions are not high. Real time characteristics are relatively bad. Opting for the use of digital transmission navigation display systems based on global satellite navigation systems avoids the shortcomings discussed above. Moreover, it is possible to conveniently generalize application to various types of mobile platforms.

II. SYSTEM USES

As far as the real time determination and, in conjunction with that, the display of the positions of such carriers as aircraft, helicopters, vehicles, ships, and so on, are concerned (latitude, longitude, and height), they show changes in dynamic states associated with carrier course direction and course speed as well as date and time to guarantee correct carrier navigation and the supplying of platform location data for the sake of carrying out electronic countermeasure missions. The contents discussed above can be transmited to ground command posts by radio to provide monitoring of the dynamics of carriers. Besides this, it is also possible--under stationary conditions--to complete positioning operations for fixed points.

III. SYSTEM FUNCTIONS

1. Navigation Display: Displaying in the form of graphic figures on a map background flight paths and course directions with a new point every second or a new point every five seconds. /40
2. Data Display: Capable of displaying, longitude, latitude, height, course direction, course speed, GMT, as well as date, and so on. Data update rate is 1 iteration/second or 5 iteration/second. In graphic figures, it is possible to use Chinese characters to display various types of parameters, indices, and so on.
3. As far as graphic figures associated with the storage and recording of flight paths are concerned, one storage time period is greater than 4 hours.
4. Printers record data.
5. After the fact, reproduction is carried out of navigation

status. Reproduction speed can be adjusted in a timely manner. Moreover, it is possible to freeze displays.

6. Data can be digitally transmited by radio in real time. Digital transmission speed is 2400 bauds/second. Each time flight altitudes are 10000 meters, air to ground transmission range is 0-100km. When it is necessary to have larger transmission ranges, it is possible to select for use stations with relatively greater transmiting power.

7. Equipment Utilization Environment. Use is required of carriers which suit high subsonic transport aircraft as well as helicopters and so on.

8. Reliability: Average malfunction time interval is greater than 250 hours.

IV. GPS DIGITAL TRANSMISSION NAVIGATION DISPLAY SYSTEM SCHEMATICS

Schematic associated with equipment on moving platforms:

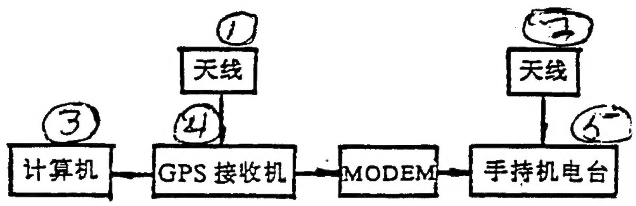

Fig.1 Principles of Equipment on Platforms
Key: (1) Antenna (2) Antenna (3) Computer (4) GPS Receiver (5) Hand Held Transmitter

Ground command post equipment schematic:

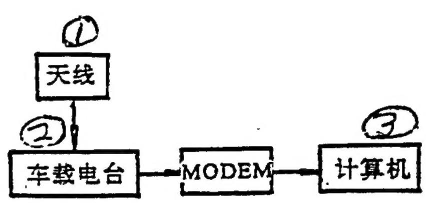

Fig.2 Command Post Equipment Schematic

Key: (1) Antenna (2) Vehicle Borne Transmiter (3) Computer

Equipment Explanation:

1. GPS receivers are maritime navigation model GPS from the U.S. Tianbao (Celestial Treasure) Company.
2. Hand held devices are Japanese (phonetic approximation: baranshi) C450.
3. Vehicle borne units are Japanese (phonetic approximation: kengo) TK-808H.
4. MODEN are Kehai Company FAST 2400TNC.
5. Computers can be 286 or higher lap tops or PC's.

V. GPS DIGITAL TRANSMISSION NAVIGATION DISPLAY SIGNAL FLOW CHARTS

1. GPS receivers carry out positioning through satellite nets. They receive signals sent out by four satellites, and are then capable of carrying out three dimensional positioning. /41 The output data language set is transmited out from I/O port (RS232).
2. Data outputed by GPS receivers is divided into two paths and, respectively, sent to computers and MODEM.
3. Computers carry out processing, calculation, storage, and display with regard to data.
4. MODEM carry out modulation of data, sending it to transmiting stations to carry out broadcast.
5. Data received by stations associated with ground command posts is sent into MODEM to carry out demodulation. Data goes through RS232 ports and is transmited out.
6. As far as MODEM outputed data is concerned, computers carry out processing, calculation, storage, and display of it.

VI. EXPLANATION OF VARIOUS CONNECTION PORTS ASSOCIATED WITH GPS DIGITAL TRANSMISSION NAVIGATION DISPLAY SYSTEMS

1. Explanation of equipment used by systems:
2. Each port is RS232, baud rate: 2400, data bits: 8 bit, verification: none, stop bit: 1 bit.
3. GPS and computer as well as MODEM port explanation:

GPS Receiver I/O Port (6 pin)	Computer COM1 Port (9 pin)	MODEM Port (25 pin)
GND(1) ------------------	GND(5) --------------	GND(7)
R+(2)	Empty	Empty
R+(3)	Empty	Empty
T+(4) --------------------	RD(2) ---------------	RD(2)
T-(5)	Empty	Empty
A-Power(6)	Empty	Empty

4. MODEM and vehicle borne unit port explanation:

#3.

```
MODEM                        Vehicle Borne        Vehicle Borne
                                 Unit                 Unit
(9 pin)                     (Square Plug)         (3.5mm Plug)
GND(7)-------------------GND------------------GND------
TX(2)--------------------MIC
PTT(4)-------------------PTT
RX(3)-----------------------------------------SPEAKER
```

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5. MODEM and hand held device port explanation:

```
MODEM                          Hand Held          Vehicle Borne
                                Device                Unit
(9 pin)                       (2.5 Plug)          (2.5mm Plug)
GND(7)------ •-------------GND------------------GND
TX(2)------- |-------------MIC
PTT(4)------ |
RX(3)-----------------------------------------SPEAKER
```

VII. GPS OUTPUT LANGUAGE EXPLANATION

In GPS input/output windows, artificial setting GPS output verification sum: NO, NMEA precision: a few thousandths, three output languages: GXP, TGA, VTG.

Concrete language formats are as follows:

$GPGXP, XXXXXX, XXXX.XXX, N, XXXXX.XXX, E,, [CR] [LF]

Data Section	Explanation
1	Fixed Position UTC
2	Latitude units are degrees, minutes, seconds (seconds are decimal system)
3	N = North Latitude, S = South Latitude
4	Longitude units are degrees, minutes, seconds (seconds are decimal system)
5	E = East Longitude, W = West Longitude

$GPTGA, XXXXX, M, XXXXX, M, XXXXX, M, [CR] [LF]

Data Section	Explanation
1	Antenna Height (Meters)
2	Elevation Above Sea Level (Meters)
3	Antenna Height Plus Elevation Above Sea Level (Meters)

$GPVTG, XXX, T, XXX, M, XXX.X, N, XXX.X, K, [CR] [LF]

Data Section	Explanation
1,2	Course Direction, True North
3,4	Course Direction, Magnetic North
5,6	Speed, Km/Hr

VIII. SOFTWARE DESIGN EXPLANATION

During actual work, there are computer serial port data communications, data internal storage management, data format conversion, document data management, graphic input and storage, graphic annotated Chinese character displays, flight parameter displays, and other such operations. For the sake of satisfying various types of actual requirements, programs opt for the use of Turbo C language in their writing.

On the basis of mission requirements during flights--because platform positions change--there are four graphic frames which need to be inputed in rotation. In order to make the internal storage which is used by graphics small and speed of transfer rapid, with, moreover, graphics being simple, clean, and clear--on the basis of map scales and display device resolutions--Turbo C graphics language is used to make modules associated with four frames of graphics, satisfying function requirements. Each graphical frame has approximately 6000 bytes. The numbers associated with image frames can be worked out on the basis of requirements. As far as image storage is concerned, option is made for the use of getimage language formats for storage.

Besides this, in order to display Chinese characters in western script DOS environments, a Chinese character display module was written.

Main program line and block chart:

In program design, option is made for the use of modularized designs. In conjunction with this, program optimization is carried out, making programs simple and clear, easy to understand, and convenient for debugging and management.

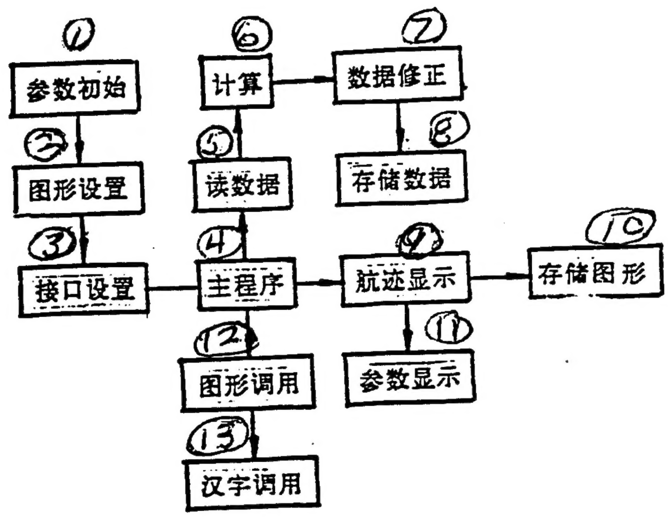

Fig.3 Program Line and Block Chart

Key: (1) Parameter Initialization (2) Graphic Settings (3) Connection Settings (4) Main Program (5) Read Data (6) Computer (7) Data Correction (8) Data Storage (9) Flight Path Display (10) Graphic Storage (11) Parameter Display (12) Graphic Transfer (13) Chinese Character Transfer

IX. PRACTICAL APPLICATION STATUS

The equipment in question has already been utilized during test flights of aircraft with certain reconnaissance equipment. The operational environment associated with the tests was relatively bad. The speed of the platform was 700km/hr. Altitude was 10500 meters. Moreover, operations were in a high density electromagnetic environment associated with 20-30 thousand pulses/second. The reliable operating range of digital transmissions was 100km. Total flight time was 20 hours. Operations were stable and reliable, guaranteeing the smooth completion of test flight missions.

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